A SIMPLE STARTING POINT FOR DESIGNING FOR AND/OR ASSESSING THE SOCIAL IMPACT OF PRODUCTS

Hans Ottosson
PhD Candidate
Dept. of Mechanical Engineering
Brigham Young University
Provo, Utah 84602

Emma Hirschi
Research Assistant
Dept. of Mechanical Engineering
Brigham Young University
Provo, Utah 84602

Christopher A. Mattson∗
Associate Professor
Dept. of Mechanical Engineering
Brigham Young University
Provo, Utah 84602
Email: mattson@byu.edu

Eric Dahlin
Associate Professor
Dept. of Sociology
Brigham Young University
Provo, Utah 84602

ABSTRACT

In this paper we present a starting point for designing for and/or assessing the social impact of engineered products. The starting point is a set of tables comprising products, their general functional characteristics, and the accompanying social impacts. We have constructed these tables by first extracting a set of social impact categories from the literature, then 65 products were qualitatively reviewed to find their social impact. The resulting product impact tables can be used at either the beginning of the product development process to decide what social impact to design for and discover product functions that lead to it, or later to qualitatively assess the social impact of a product being designed and/or to assess the impact of an existing product.

1 INTRODUCTION/LITERATURE RESEARCH

Engineers design for the purpose of creating value and improving lives. While so doing, they seek efficient ways to turn the Earth's resources into meaningful and impactful objects. Explicit in the engineer's product development process is the evaluation of financial value created, and the environmental cost of that value. *Implicit* to the process, however, is the evaluation of social value created – or social impact.

The creation and measurement of positive social impact is a fundamental part of global development, yet doing so has proven difficult. In a survey carried out by Nonprofit Technology Network (NTEN), only half of the organizations that responded collected data on end-user impact [1] and another study reported that more than 70 percent of those giving grants to NGOs said that the foundations did not have the necessary data to measure their impact [2]. Rainock et al. state that "the consequences of innovation remain conceptually under-developed and under-examined" [3].

The current lack of product development tools that can be used to create and measure the social impact of engineered products is a barrier that will keep engineers from maximizing their impact on global development. Simply stated, those working

---

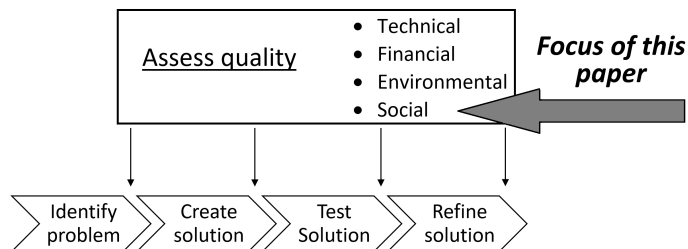∗Address all correspondence to this author.

Figure 1. Product development process adapted from Fundamentals of Product Development [4]

in the area of *engineering for global development* would benefit from formalized tools aimed at social impact.

We recognize that the concept of social impact is broad and can easily become unwieldy. In this paper we explore a simple starting point – a way to get started with the difficult task of designing for and/or assessing the social impact of an engineered product. We do not attempt in this paper to solve all of the engineer's challenges with social impact modeling. On the contrary, we raise the topic and provide a way to get started. To be clear, our focus is shown in Figure 1. Throughout the product development process, the quality of the developed solution will be assessed as shown in the figure. For assessing technical, financial, and environmental areas, numerous methods exist in the literature. But the last area – the assessment of social impact – is relatively unknown, and therefore tools to aid engineers are unavailable. Unfortunately, this leaves social impact as something many engineers want to pursue, but have no tools to do so. Doineau from NTEN said that "Assessing the impact that you're making is no simple task, in part because the tools are still being developed to do this and vary widely based on the purpose of the assessment" [5]. The reality is that due to the current lack of methods for assessing social impact of products, it is typically not measured or considered even though all products have social impact [2].

The purpose of this paper is to create a starting point to design for and/or assess social impact of engineered products. We have done this by creating a set of tables where general product functions are linked to social impact categories. In these tables, existing products are listed with corresponding social impact categories, a brief product description, and the product's general function that leads to the stated social impact. These product impact tables can be used at either the beginning of the product development process to decide what social impacts to design for and discover product functions that lead to it, or later to qualitatively assess the social impact of a product being designed and/or to assess the impact of an existing product.

2 DEVELOPMENT OF PRODUCT IMPACT TABLES

In this section, we describe how we created the product impact tables, and explored their potential use in the product development process. Our approach is illustrated in Figure 2, which shows three main parts. The left side showing collected data, the center portion showing the creation of the product impact tables, and the right side showing the use of the tables. Each of these parts is not briefly discussed.
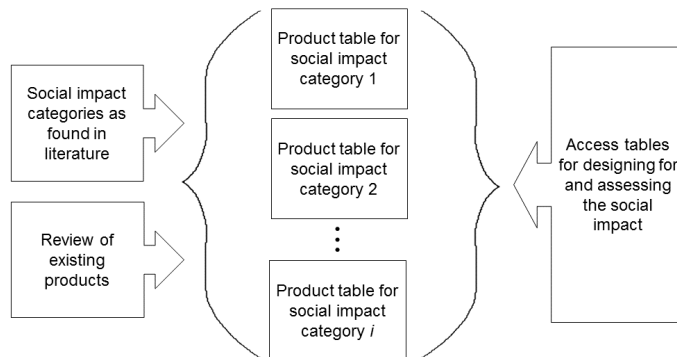

Figure 2. Approach to categorize social impact of products

The left-hand side shows two parts to the data collection; a review of the literature on social impact categories, and a review of existing products. The data related to the review of social impact categories comes from a different work by the authors of this paper (Dahlin and Mattson) [3]. For visual simplicity, we have organized the data into the form shown in Table 2. This table has three major impact categories, shown as columns, and multiple sub-categories shown as rows. Note that there is no implied importance or other meaning to the positioning columns or rows. Each of these categories, and subcategories, is discussed further in Section 3.

The second area of data collection was in qualitatively reviewing 65 products that we believe have a social impact. The set of products reviewed is not exhaustive, and products were selected from our own lists and from Emily Pilliton's book *Design Revolution: 100 Products that Empower People*. The products reviewed are shown in Figure 3 with their name and reference in Table 1.

The center portion of Figure 2 has the construction of the product impact tables. One table was constructed for each social impact category (i.e., each column of Table 2). Each table was populated with products deemed to affect social impact in that category. For each product three researchers reviewed the product, discussed it, and then mapped it to as many social impact categories as seemed reasonable. Then the same three researchers looked at each product and tried to extract the key functional

2   Copyright © 2017 ASME

Table 1. List of included products

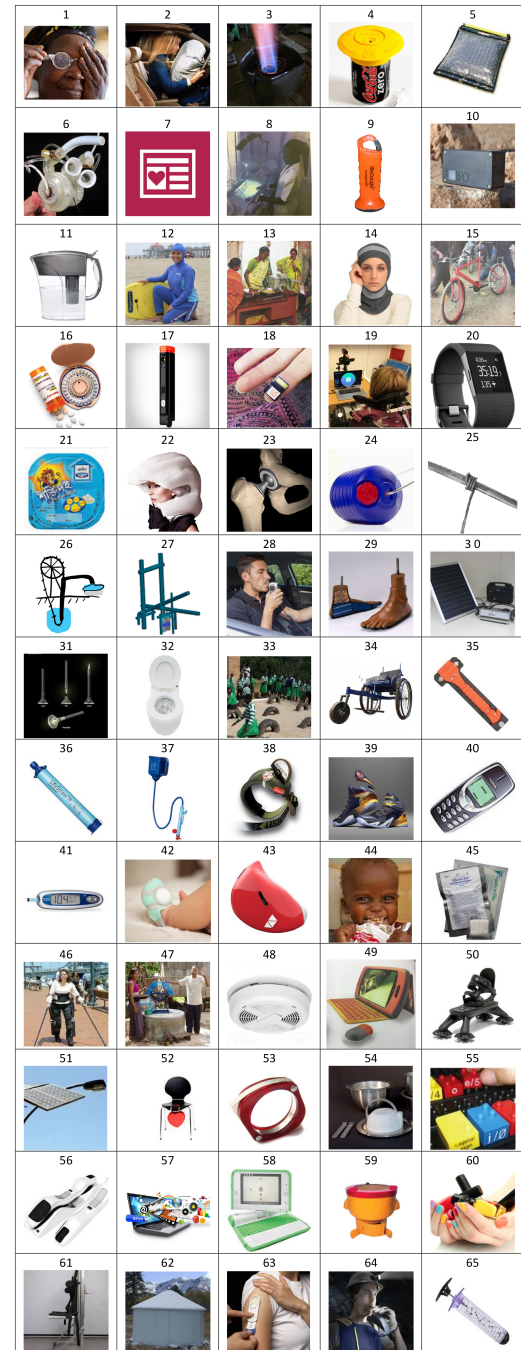| #	Product name	Source
1	Adaptive Eyecare	[6]
2	Airbag	[7]
3	Alcohol Stoves	[6]
4	Antivirus	[6]
5	AquaPak	[6]
6	Artificial heart	[8]
7	Aspire News App	[9]
8	BlueRay Phototherapy	[6]
9	BOGO Light	[6]
10	BRCK	[10]
11	Brita Filters	[6]
12	Burkini	[11]
13	Burr Mill	[6]
14	Capster	[12]
15	Chop and Drop Worldbike	[6]
16	Contraceptives	[13]
17	Defender 24/7	[14]
18	eGranery Pocket Library	[6]
19	Eye Conductor	[15]
20	FitBit	[16]
21	Grameen Danone	[6]
22	Hövding Airbag	[17]
23	Hip replacement	[8]
24	Hippo roller	[6]
25	iDE Drip Irrigation	[18]
26	iDE Rope Pump	[19]
27	iDE Treadle Pump	[18]
28	Ignition Interlock Device (IID)	[20]
29	Jaipur Foot	[6]
30	Kinkajou Microfilm Projector and Portable Library	[6]
31	Lampen	[21]
32	Laveo	[22]
33	Learning Landscape	[6]
34	Leveraged Freedom Chair	[23]
35	Life Hammer	[24]
36	LifeStraw	[6]
37	LifeStraw Family	[25]
38	Mechanical Advantage Tourniquet	[6]
39	Nike Flyease	[26]
40	Nokia 1100	[27]
41	OneTouch UltraMini Blood Glucose Meter	[6]
42	Owlet Smart Sock	[28]
43	Pilot	[29]
44	Plumpy'nut	[6]
45	QuickClot Interventional	[30]
46	ReWalk Personal 6.0	[31]
47	ROVAI Rope Pump	[6]
48	Smoke Detector	[7]
49	Spark	[6]
50	Spider Boot	[6]
51	StarSight Project	[6]
52	Stop Thief Anti-Theft Furniture	[6]
53	Subtle Safety Ring	[6]
54	Sudanese Refugee Cookware	[6]
55	Tack-Tiles Braille System	[6]
56	Tactile Wand	[6]
57	Tessera	[6]
58	The XO	[6]
59	UGASTOVE	[6]
60	Undercover Colors	[32]
61	Uplift	[33]
62	Uti Yurt	[34]
63	Vaccine Patch - Transcutaneous Immunization	[6]
64	Vald	[35]
65	XSTAT 30	[36]

Figure 3. Reviewed products (see Table 1 for product names)

characteristic that caused or enabled the social impact. The resulting tables are Tables 4, 3, and 5.

The right-hand side of Figure 2, shows that we then evaluated a few ways the product impact tables could be used to facilitate designing for and/or assessing the social impact engineered products.

3

Copyright © 2017 ASME

Table 2. Social Impact Categories [3]

Well-being and inequality	Demographics	Interaction and identity
Health and safety Impact	*Education Impact*	*Conflict and crime Impact*
Safety and security (real and perceived), activity/exercise, secure living conditions, safe living conditions, mental and physical health, mortality, improvement of life/health from product	Education, skills, empowerment	Potential conflicts, crimes, increased or decreased substance abuse, potential of assault
Paid work Impact	*Family Impact*	*Networks and communication Impact*
Change in employment rates, industrial diversification/change in economic focus	Alteration in family roles, structure, violence, stressors, ties and role in society	Impaired or improved personal relations, social capital, networks reliance on participation in decision making process
Stratification Impact	*Gender Impact*	*Cultural identity/heritage Impact*
Change in job opportunities, inequality, introduction of new classes, social status, social mixing	Gender roles, violence, stressors, inequality	Weakening/strengthening of values, respect for indigenous and minority rights, cultural intolerance, personality traits
Civil rights Impact	*Population change Impact*	
Minority rights, democracy/decision making participation	Transiency of population, age structure, presence of seasonal population	

As will be shown in Section 4, the tables can be used at either the beginning of the product development process to decide what social impact to design for and discover product functions that lead to it, or later to qualitatively assess the social impact of a product being designed and/or to assess the impact of an existing product.

3 PRODUCT IMPACT TABLES

The purpose of this section is to present the product impact tables and describe of its parts. One table was constructed for each top-level social impact category in Table 2: Well-being and inequality, demographics, and interaction and identity. Each of the three tables has the same layout (see Tables 3, 4, and 5). The first column shows the social impact sub-category from Table 2, the second column shows the reviewed products, the third column provides the general functions of the products as they relate to social impact, and the last column provides a brief product description.

The following sections provide definitions and further explanations of the social impact categories.

3.1 Well-being and Inequality

The first category is well-being and inequality with sub categories health and safety impact, paid work impact, stratification impact, and civil rights impact [3]. This category deals with social impacts that affect areas such as health, class status, and prospect for jobs. Examples of products that impact this category include water purifiers, irrigation equipment, and wheelchairs. These and other products can be found in Table 3.

3.1.1 Health and Safety Impact Health is said to be "a state of well-being" [37]. This state of well-being can be impacted by the products an individual is surrounded by. Products can impact health and safety and are therefore considered when taking a holistic view of a product [38,39]. One example of products with impact in this area is Adaptive Eyecare since it allows eyeglass functionality to be easily customized to individuals. Table 3 show many other products that can also affect health and safety.

3.1.2 Paid Work Impact Paid work is referring to employment opportunities that can be found within a community that are available to individuals. It also refers to changes in employment rates and economic focus due to a company and their products [38]. While some products can increase the amount of available jobs in a region, other products can simplify work tasks and thus have a negative impact on the amount of jobs in a community and thus impact the local and personal economy [40–42]. Successfully gaining employment has a great impact on the worker's self-esteem and leads to other positive outcomes such as greater ability to afford food and shelter. Table 3 also shows products with impact in this area.

3.1.3 Stratification Impact Stratification is the key to understanding the issues of class and the formation of status [43]. Its purpose is to place people in a social rank according to their contribution to and their worth to society, resulting in inequalities [37, 44]. A product has high social impact if it enables education and learning, which in turn can give a person higher social

4

Copyright © 2017 ASME

ranking. Table 3 show products relating to this category.

3.1.4 Civil Rights Impact
Civil rights "are those liberties, immunities and benefits which, by accepted contemporary values, all human being should be able to clam 'as of right' of the society in which they live" [45]. Since a product can have both a positive and a negative impact on civil rights, these rights must be taken into consideration and must be protected and justified by everyone [3]. These rights are the embodiment of the collective conscience of a society [37]. Examples of products that can have social impact in this area are wheelchairs and applications that can assist people in unhealthy relationships to escape. See Table 3 for more products that impact civil rights.

3.2 Demographics
The second top-level social impact category is demographics with sub-categories in education impact, family impact, gender impact, and population change impact [3]. Products such as shelters, inexpensive computers, projectors, and lamps are examples of products that have social impacts in these subcategories. Table 4 lists a number of products that have this impact.

3.2.1 Education Impact
Education is the opportunity or process for gaining new knowledge and capabilities. It can be acquired formally or informally [38, 39]. Access to education will have great social impact and improve the lives of those involved [46, 47]. It can also empower the students [38]. As shown in Table 4, products such as lamps and computers creates impacts in this area.

3.2.2 Family Impact
Family is a close domestic group bounded by blood or legal ties. This union is traditionally for raising children [43]. Products can create stronger bonds within the family unit and also cause a change in how each member perceives their individual role [3]. Two examples of products that have social impact on families are a shelter and a cook stove. Table 4 cover products in this area.

3.2.3 Gender Impact
Gender is the reference to the social norms and the difference with being male or female. This category also includes how a product can impact the gender roles, inequality, and gender-based violence [43]. The impact can be both within a family or in society as a whole [48, 49]. Example of products that have impact in the area of gender are pepper spray and burkini. See Table 4 for more impacts.

3.2.4 Population Change Impact
Population change is a measure that accounts for the deaths, births, and the move-ins/move-outs of a population [37]. Population change

can be linked to products [42]. One example is a product that influences a population in such a way that it causes move-ins/move-outs of the population [42] – such as an irrigation or sanitation system being added to a community, thus increasing the desirability of that community. Another product that impacts this area is shelter. See Table 4 for impacts in this area.

3.3 Interaction and Identity
The last top-level social impact category is interaction and identity with sub-categories of conflict and crime impact, networks and communication impact, and cultural identity/heritage impact [3]. Mobile phones, ignition locks, and cameras are examples of products in this area. Table 5 has these and other products linked to impacts in the area of interaction and identity.

3.3.1 Conflict and Crime Impact
Conflicts are activities that are against the ruling social setting. It can be both positive and negative. On the one hand, conflict can strengthen a group's purpose and identity. But, on the other hand, conflict can groups to fracture and break up [37]. Crime is defined as a violation of set laws [43]. Conflicts are usually punished by the social network while crimes are punished by set laws [37]. Products can be used to prevent, but also to perpetrating a crime. Breathalyzer, pepper spray, and security cameras are some examples of products related to impacts in this area. Table 5 cover these impacts.

3.3.2 Networks and Communication Impact
A network is "a finite set of actors and the relation or relations defined on them" [50]. Networks can be divided into three social units: Micro level (small groups), meso level (organizations or fields), and macro level (cities or nations). These levels can have no connections, weak connections, or strong connections between them [37]. Product impacts can make network connections and the bond within a level stronger or weaker, even to the dissolving of a them [46, 49, 51].

Communication is the "process by which messages are transferred from a source to a receiver" [52]. It is found in every social situation and can be broken up into five different types of communication: Conversation with self, face-to-face interactions, group communication, mass communication, and non-human communication (communication with machines and computers). The type of communication that is carried out and the effectiveness of it can have great impact on social systems [43]. Garton and Wellman points out that products can change how communication is done [49].

Mobile phones, wifi hotspots, and translation devices are some examples of products in this area. See Table 5 for products impacting networks and communication.

5

Copyright © 2017 ASME

Table 3. Well-being and Inequality

Social impact	Product	General product function	Product description
Health and safety	Spider Boot	Protects from outside harm	Boot with a deflector shell that absorbs shock waves
Health and safety	LifeStraw	Protects from outside harm	Filter that purifies water
Health and safety	Airbag	Protects from outside harm	Module that inflates rapidly during collision to prevent injury
Health and safety	Hövding Airbag	Protects from outside harm	Collar that contains an inflatable airbag helmet
Health and safety	Hippo roller	Provides access to resources	Water barrel transportation device
Health and safety	Ignition Interlock Device (IID)	Protects from outside harm	Ignition locking breathalyzer device
Health and safety	Owlet Smart Sock	Monitors health	A sock with pulse oximetry technology that monitors vitals
Health and safety	Lampen	Improves quality of life	Self electrifying pen that provides light
Health and safety	ReWalk Personal 6.0	Improves quality of life	A full body mobility device for paraplegics
Health and safety	Uplift	Improves quality of life	A chair with a pulley system to assist individuals with Cerebral Palsy
Health and safety	Nike Flyease	Improves quality of life	A style conscious shoe with a velcro and zipper system
Health and safety	XSTAT 30	Protects from injury	A biocompatible sponge filled syringe to stop bleeding
Health and safety	Laveo	Prevents contamination	A toilet with a dry bagging system that disposes of waste without water
Health and safety	Uti Yurt	Provides shelter	A economic durable shelter
Health and safety	Life Hammer	Prevents injury	A tool to break car windows with minimal force
Health and safety	QuickClot Interventional	Improves health	A hemorrhage control device that absorbs blood
Health and safety	BlueRay Phototherapy	Improves health	An affordable infant phototherapy device with long-lasting LED lights
Health and safety	Adaptive Eyecare	Improves quality of life	Adjustable eyeglasses
Health and safety	Vald	Prevents injury	A portable oxygen supply for miners
Health and safety	Hip replacement	Improves quality of life	A fabricated steel/polyethylene hip joint
Health and safety	Artificial heart	Improves surgical capacities	A machine that circulates blood throughout the body
Health and safety	Smoke Detector	Prevents bodily and property harm	A mechanism that alerts when smoke is detected
Health and safety	Antivirus	Prevents health risk	Turns a soda can into a disposal for needles
Health and safety	Vaccine Patch - Transcutaneous Immunization	Improvement of Health	Needle-free alternative for immunization
Health and safety	BOGO Light	Improves quality of life	Solar LED flashlight that lasts for over 100,000 hours
Health and safety	Tactile Wand	Prevents injury	Digital version of a walking stick for the blind
Health and safety	FitBit	Improvement of Health	Digital tracker for steps
Health and safety	Alcohol Stoves	Prevents health risk	Stove designs that use only parts available in developing countries to cook food
Health and Safety	AquaPak	Improves health	Portable, solar water purifier
Health and Safety	Brita Filters	Improves health	Affordable home water filter
Health and Safety	ROVAI Rope Pump	Improves health	Developing world water pump
Health and Safety	Jaipur Foot	Increase in quality of life	Low-cost prosthesis
Health and Safety	Mechanical Advantage Tourniquet	Decrease risk of injury	Self administered tourniquet
Health and Safety	OneTouch UltraMini Blood Glucose Meter	Increase in quality of life	Affordable, pain reducing diabetic glucose meter
Health and Safety	Leveraged Freedom Chair	Improves quality of life	Low cost all terrain wheelchair
Health and Safety	Plumpy'nut	Combats malnutrition	Bars with high nutritional value
Health and Safety	Grameen Danone	Combats malnutrition	Affordable yogurt that compensates for nutritional deficiencies
Paid work	Burr Mill	Increases earning potentials	An economic crop mill
Paid work	UGASTOVE	Increases earning potentials	Create affordable stove designs that allow upward mobility
Paid work	iED Treadle Pump	Increases earning potentials	Affordable solar pump to increase crop yield
Paid work	iED Rope Pump	Increases earning potentials	Affordable rope water pump to increase crop yield
Paid work	iED Drip Irrigation	Increases earning potentials	Affordable drip irrigation to reduce labor needs
Stratification	Pilot	Reduces cultural barriers	Earphones that translates languages in real time
Stratification	eGranary Pocket Library	Enables education	High-quality educational pocket library
Stratification	Lampen	Enables education	Self electrifying pen that provides light
Stratification	The XO	Enables education	Laptop for developing worlds
Stratification	Leveraged Freedom Chair	Increases user mobility	Low cost all terrain wheelchair
Stratification	Chop and Drop Worldbike	Increases user mobility	Open-source design for a bike that can be built using common worldwide materials
Stratification	Hippo roller	Provides essential need	Water barrel transporation device
Civil rights	Undercover Colors	Protects from outside harm	Nail polish that identifies date rape drugs
Civil rights	Aspire News App	Protects from domestic violence	A hidden app used to escape domestic violence
Civil rights	Leveraged Freedom Chair	Increases user participation	Low cost all terrain wheelchair

6

Copyright © 2017 ASME

Table 4. Demographics

Social impact	Product	General product function	Product description
Education	The XO	Provides opportunity for learning	Laptop for developing worlds
Education	Spark	Provides opportunity for learning	Mobile learning tool
Education	Tack-Tiles Braille System	Provides opportunity for learning	Interactive braille block learning system
Education	Lampen	Makes reading possible in low-light	Self electrifying pen that provides light
Education	eGranery Pocket Library	Provides knowledge resources	A compact microchip database with educational materials
Education	Kinkajou Microfilm Projector and Portable Library	Provides opportunity for learning	Literacy library with a solar-powered projector
Education	Learning Landscape	Provides opportunity for learning	Playgrounds that teach math using games
Education	Tessera	Promotes interactive education	Interactive educational game for refugees
Family	Aspire News App	Protects from domestic violence	A hidden app used to escape domestic violence
Family	LifeStraw Family	Alterations in family stressors	Provides a common water source for basic household chores
Family	Sudanese Refugee Cookware	Alterations in family stressors	Easy to transport cookware for refugees
Gender	Aspire News App	Protects from domestic violence	A hidden app used to escape domestic violence
Gender	Burkini	Preserves religious beliefs	Modest Muslim swim wear that is lightweight when wet
Gender	Defender 24/7	Reduces risk of harm	Pepper spray that photographs the attacker
Gender	Capster	Preserves religious beliefs	Athletic hijab that is breathable and lightweight
Gender	Undercover Colors	Reduces risk of harm	Nail polish changes color when detecting date rape drugs
Gender	Subtle Safety Ring	Reduces risk of harm	Rings that come to a point on one edge to be used in self defense
Population change	Uti Yurt	Provides shelter	A economic durable shelter
Population change	Contraceptives	Enables family planning	A device or drug that prevent pregnancy

3.3.3 Cultural identity and heritage Impact

"Cultural heritage is an expression of the ways of living, developed by a community and passed on from generation to generation, including customs, practices, places, objects, artistic expressions and values" [53]. Products can influence the ways that this cultural heritage is passed on from generation to generation and thus change the identity and heritage of a culture [39, 51, 54]. Examples of products that impact this area are Burkini for keeping an identity/faith and an irrigation system that enables families to retain members locally instead of moving away in search of employment. See Table 5 for more information on these products.

3.4 General Product Functions

Each of the tables provided in this section have also included a column listing an abstracted, general product function. This column is designed to direct the engineer to functions that could be pursued as part of a new socially-oriented development effort. For example, the first row of Table 5, shows "prevents illegal activity" as a general function. While the product being described is an automobile ignition locking system based on breathalyzer results, the notion of preventing illegal activity can be applied to numerous ideas unrelated to driving while intoxicated. Such general functions are included in the table to help engineers envision how incorporating one or more of these general product functions can lead to social impact in one or more of these categories.

4 HOW TO USE THE PRODUCT IMPACT TABLES

We now describe how the product impact tables presented in the previous section may be used in the product development process. We recommend two possible ways to use the tables. First, the tables can be used to design for social impact. Those seeking to design for social impact can do the following to benefit from the tables:

1. Establish social impact goals, by reviewing the social impact categories in Table 2 and choosing one or more impact categories that aligned with their interests, mission, skills, and/or opportunities.
2. Understand how other products have had a social impact in the chosen impact category by reviewing the products listed in the corresponding table (see Tables 3, 4, and 5) and social impact sub-category (column 1).
3. Generate new product ideas inspired by the abstracted general functional characteristic known to lead to social impact in the chosen area.

Another way the product impact tables can be used during product development is to assess a product's social impact during or after its development. To do this, the following steps can be used to assess the social impact the product can have:

1. Evaluate the current product's general functional characteristics and find all matching functions listed in the third column of all product impact tables.
2. Assess how well the current product leads to or contributes to the social impact sub-category and category listed in the corresponding table.
3. If the product being assessed can be improved, do so considering the potential social impacts offered in the categories identified in Step 2, directly above.

While there are likely to be other ways these tables can be

7

Table 5. Interaction and Identity

Social impact	Product	General product function	Product description
Conflict and crime	Ignition Interlock Device (IID)	Prevents illegal activity	Ignition locking breathalyzer device
Conflict and crime	Defender 24/7	Increases self defense of user	Image capturing bluetooth peperspray that creates photo evidence and alerts police
Conflict and crime	Undercover Colors	Increases awareness of user	Nail polish that identifies date rape drugs
Conflict and crime	Defender 24/7	Reduces risk of harm	Pepperspray that photographs the attacker
Conflict and crime	Undercover Colors	Reduces risk of harm	Nail polish changes color when detecting date rape drugs
Conflict and crime	StarSight Project	Reduces crime	Reliable solar lighting to keep public areas lit
Conflict and crime	Stop Thief Anti-Theft Furniture	Reduces crime	Furniture that discourages theft through natural placement of obstacles
Conflict and crime	Subtle Safety Ring	Reduces risk of harm	Rings that come to a point on one edge to be used in self defense
Networks and communication	Eye Conductor	Improves communication for disabled	Allows disabled to play music
Networks and communication	BRCK	Increased connectivity of developing countries	Durable wifi hotspot box providing mobile wifi
Networks and communication	Nokia 1100	Increased connectivity of developing countries	Durable, multi-purpose phone
Networks and communication	Pilot	Reduces cultural barriers	Earphones that translates languages in real time
Networks and communication	Leveraged Freedom Chair	Increase in mobility	Low cost all terrain wheelchair
Cultural identity/ heritage	iED Treadle Pump	Promotes staying in a community vs migration	Affordable solar pump to increase crop yield
Cultural identity/ heritage	iED Rope Pump	Promotes staying in a community vs migration	Affordable rope water pump to increase crop yield
Cultural identity/ heritage	iED Drip Irrigation	Promotes staying in a community vs migration	Affordable drip irrigation to reduce labor needs
Cultural identity/ heritage	Burkini	Maintains religious beliefs	Modest Muslim swim wear that is lightweight when wet
Cultural identity/ heritage	Capster	Allows athleticism while preserving religious beliefs	Athletic hijab that is breathable and lightweight

used, we believe that the two areas described here could benefit those working to assess and improve the social impact of engineered products.

5 DISCUSSIONS

In this paper we have provided a set of product impact tables, which we have described as a starting point for designing for or qualitatively assessing the social impact of products. We have built on existing social impact categories from the literature and 65 existing products on the market. The tables have linked products to the social impact categories, and provided general product functions that lead to social impact. The latter is designed to help engineers envision how a product's functional characteristics lead to social impact. Two simple approaches are provided to guide engineers in using the product impact tables.

The presented material is limited in the following important ways. While the social impact categories presented are based on an extensive literature survey [3], the reviewed products are not extensive nor exhaustive. While we believe that all products have a social impact, and thus an exhaustive survey is not possible, we do believe that the extent of the review can be expanded. The assessment of products and the social impact of those products is qualitative. While we believe that a quantitative assessment would be extremely valuable, we have only carried out a qualitative assessment becuase quantiative assessments of social impact don't yet exist.

Ultimately, we believe that the contribution of this paper lies in the linking of products to social impact categories and the linking of a product's general function to social impact categories. As such it alerts the engineer to various social impact areas that are not commonly considered during the product development process. The tables further inspire the engineer by listing products and product functions that already exist and contribute to even the most obscure of the social impact cateogories.

REFERENCES

[1] Idealware, 2012. The State of Nonprofit Data 2012. Tech. Rep. November, NTEN: The Nonprofit Technology Network. 1

[2] Epstein, M. J., and Yuthas, K., 2015. "Measuring and im-

8

proving social impacts : A guide for nonprofits, companies, and impact investors". 1, 2

[3] Rainock, M., Everett, D., Pack, A., Dahlin, E., and Mattson, C. A., 2017. "A Review of the Antecedents and Consequences of Innovation". American Sociological Association. 1, 2, 4, 5, 8

[4] Mattson, C., and Sorensen, C., 2016. *Fundamentals of Product Development*. CreateSpace Independent Publishing Platform. 2

[5] NTEN, 2017. It is time to plan your ntc! 2

[6] Pilloton, E., 2009. *Design Revolution: 100 Products that Empower People*. Metropolis Books. 3

[7] Craughwell, T., 2008. *The Book of Invention*. Tess Press, LLC. 3

[8] Challoner, J., 2009. *1001 Inventions that Changed the World*. Barron's. 3

[9] Kreitz, K. "Nineteenth-Century Media in Transition: Rewiring New York's New Journalism and the US Realist Novel When Rupert Murdoch launched The Daily last February, he billed the news âĂIJappâĂİ designed exclusively for the iPad as an experiment in updating journalism fo". 3

[10] Premkumar, R., 2014. "Wireless Networks for Disaster Relief". *Department of Computer Science and Engineering, Washington University in St. Louis*. 3

[11] Hamzeh, M., and Oliver, K. L., 2012. ""Because I Am Muslim, I Cannot Wear a Swimsuit" Muslim Girls Negotiate Participation Opportunities for Physical Activity". *Research quarterly for exercise and sport, 83*(2), pp. 330–339. 3

[12] Tarlo, E., 2010. "Hijab online: the fashioning of cyber Islamic commerce". *interventions, 12*(2), pp. 209–225. 3

[13] Seltzer, J. R., 2002. *The Origins and Evolution of Family Planning Programs in Developing Countries*. Online Rand research documents. RAND Corporation. 3

[14] Anthony Domanico August 22, . . A. M. P. D. T. a., 2014. Pepper spray gets a camera with The Defender, aug. 3

[15] Asakawa, T., and Kawarazaki, N., 2012. "An electric music baton system using a haptic interface for visually disabled persons". In SICE Annual Conference (SICE), 2012 Proceedings of, IEEE, pp. 602–607. 3

[16] Takacs, J., Pollock, C. L., Guenther, J. R., Bahar, M., Napier, C., and Hunt, M. A., 2014. "Validation of the Fitbit One activity monitor device during treadmill walking". *Journal of Science and Medicine in Sport, 17*(5), pp. 496–500. 3

[17] Nayak, R., Padhye, R., Sinnappoo, K., Arnold, L., and Behera, B. K., 2013. "Airbags". *Textile Progress, 45*(4), pp. 209–301. 3

[18] Postel, S., Polak, P., Gonzales, F., and Keller, J., 2001. "Drip irrigation for small farmers". *Water International, 26*(1), pp. 3–13. 3

[19] Polak, P., 2009. *Out of Poverty: What Works When Traditional Approaches Fail*. Berrett-Koehler Publishers. 3

[20] Coben, J. H., and Larkin, G. L., 1999. "Effectiveness of ignition interlock devices in reducing drunk driving recidivism". *American Journal of Preventive Medicine, 16*(1), pp. 81–87. 3

[21] Core77, 2016. Lampen - Core77 Design Awards. 3

[22] Kim, Y., Hashemi, S., Han, M., Kim, T., and Sohn, H.-G., 2016. "The Waterless Portable Private Toilet: An Innovative Sanitation Solution in Disaster Zones". *Disaster medicine and public health preparedness, 10*(02), pp. 281–285. 3

[23] Winter, A. G., Bollini, M. A., Judge, B. M., Scolnik, N. K., O'Hanley, H. F., Dorsch, D. S., Mukherjee, S., and Frey, D. D., 2012. "Stakeholder-driven design evolution of the leveraged freedom chair developing world wheelchair". In ASME 2012 International Mechanical Engineering Congress and Exposition, American Society of Mechanical Engineers, pp. 361–368. 3

[24] Lechner, H., 1986. Device installed in passenger cars for smashing windows after traffic accidents. 3

[25] Clasen, T., Naranjo, J., Frauchiger, D., and Gerba, C., 2009. "Laboratory assessment of a gravity-fed ultrafiltration water treatment device designed for household use in low-income settings". *The American Journal of Tropical Medicine and Hygiene, 80*(5), pp. 819–823. 3

[26] Hums, M. A., Schmidt, S. H., Novak, A., and Wolff, E. A., 2016. "Universal Design: Moving the Americans With Disabilities Act From Access to Inclusion.". *Journal of Legal Aspects of Sport, 26*(1). 3

[27] Sharma, S., 2009. "Rural India Calling". *USID Foundation, September*. 3

[28] King, D., 2014. "Marketing wearable home baby monitors: real peace of mind?". *BMJ: British Medical Journal (Online), 349*. 3

[29] Manu, D., 2016. Meet the Pilot: Smart Earpiece Language Translator. 3

[30] Trabattoni, D., Gatto, P., and Bartorelli, A. L., 2012. "A new kaolin-based hemostatic bandage use after coronary diagnostic and interventional procedures". *International journal of cardiology, 156*(1), pp. 53–54. 3

[31] Lajeunesse, V., Vincent, C., Routhier, F., Careau, E., and Michaud, F., 2016. "Exoskeletons' design and usefulness evidence according to a systematic review of lower limb exoskeletons used for functional mobility by people with spinal cord injury". *Disability and Rehabilitation: Assistive Technology, 11*(7), pp. 535–547. 3

[32] Germain, L. J., 2016. *Campus Sexual Assault: College Women Respond*. JHU Press. 3

[33] , 2016. Uplift - by Stefano Pagain and Amit Nir / Core77 Design Awards. 3

[34] Foldedhomes, 2008. Folded Homes - Folded Homes Yurts.

3

[35] , 2016. Vald - by Emin Demirci / Core77 Design Awards. 3

[36] Voelker, R., 2016. "From Soldiers to Civilians". *Jama, 315*(5), p. 456. 3

[37] Ritzer, G., and Ryan, J. M., 2011. *The concise encyclopedia of sociology*, 1 ed. Wiley-Blackwell, Chichester, UK. 4, 5

[38] Fontes, J., 2016. *Handbook-for-Product-Social-Impact-Assessment-3.0*, 3 ed. PRé Sustainability. 4, 5

[39] Weingaertner, C., and Moberg, s., 2014. "Exploring social sustainability: Learning from perspectives on urban development and companies and products". *Sustainable Development, 22*(2), pp. 122–133. 4, 5, 7

[40] Ogburn, W. F., and Nimkoff, M. F., 1950. *Sociology*. Houghton Mifflin. 4

[41] Bray, F., 1978. "Swords into Plowshares : A Study of Agricultural Technology and Society in Early China". *Technology and Culture, 19*(1), pp. 1–31. 4

[42] Okeagu, J. C. J. E., Okeagu, J. C. J. E., Adegoke, A. O., and Onuoha, C. N., 2006. "the Environmental and Social Impact of Petroleum and Natural Gas Exploitation in Nigeria". *Journal of Third World Studies, 23*(1), pp. 199–218. 4, 5

[43] Scott, J., and Marshall, G., 2009. *A Dictionary of Sociology*. Oxford Dictionary of Sociology. Oxford University Press. 4, 5

[44] Grusky, D. B., and Weisshaar, K. R., 2014. *Social Stratification: Class, Race, and Gender in Sociological Perspective*. Westview Press. 4

[45] Bernhardt, R., and Bindschedler, R.L., i. u. y. p. *Encyclopedia of Public International Law*. 5

[46] Donner, J., 2009. "Blurring Livelihoods and Lives: The Social Uses of Mobile Phones and Socioeconomic Development". *Innovations, 4*(1), pp. 91–101. 5

[47] Cowan, R. S., 1976. "The "Industrial Revolution" in the home: household technology and social change in the 20th century". *Technology and Culture, 17*(1), pp. 1–23. 5

[48] Schwartz, M., 1976. *Radical protest and social structure: the Southern Farmers' Alliance and cotton tenancy, 1880-1890*. Studies in social discontinuity. Academic Press. 5

[49] Garton, L. E., and Wellman, B., 1993. Social impacts of electronic mail in organizations: A review of the research literature. Tech. rep., Ontario Telepresence Project. 5

[50] Wasserman, S., and Faust, K., 1994. *Social Network Analysis: Methods and Applications*. Structural Analysis in the Social Sciences. Cambridge University Press. 5

[51] Wheatley, M. A., 1997. Social and cultural impacts of mercury pollution on Aboriginal peoples in Canada. 5, 7

[52] Rogers, E. M., and Shoemaker, F. F., 1971. *Communication of innovations: a cross-cultural approach*, 2 ed. Free Press. 5

[53] Nzeadibe, T. C., Ajaero, C. K., Okonkwo, E. E., Okpoko, P. U., Akukwe, T. I., and Njoku-Tony, R. F., 2015. "Integrating community perceptions and cultural diversity in social impact assessment in Nigeria". 7

[54] Gramling, R., and Freudenburg, W. R., 1992. "Opportunity-threat, development, and adaptation: Toward a comprehensive framework for social impact assessment". *Rural Sociology, 57*(2), pp. 216–234. 7